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USSR Report

MACHINE TOOLS AND METALWORKING EQUIPMENT

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USSR REPORT

MACHINE TOOLS AND METALWORKING EQUIPMENT

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 [III - USSR - 36b]

INDUSTRY PLANNING AND ECONOMICS

BALMONT ON IMPLEMENTATION, UTILIZATION OF NEW MACHINE TOOLS

Moscow PLANOVOYE KHOZYAYSTVO in Russian No 7, Jul 85 pp 3-9

[Article by B. Balmont, chairman of the State Consultancy Commission on Questions of the Distribution and Utilization of Metalworking Equipment in the National Economy and Minister of the Machine Tool and Tool Building Industry: "Improvement of the System for Distributing and Using Metalworking Equipment"]

[Text] The Communist Party and the Soviet Government are paying constant attention to the development of domestic machinebuilding--the branch which has emerged as the chief accelerator of progress in the whole national economy--and to the shaping and improvement of the country's production equipment, including the pool of industrial equipment within machinebuilding itself.

The decisive role of machinebuilding in reequipping all branches of the national economy, based upon modern achievements of science and technology, was especially noted at the April 1985 CPSU Central Committee Plenum and the meeting of the CPSU Central Committee on speeding up scientific and technical progress. "Paramount attention," the Plenum's report stated, "should be paid to improving machine-toolbuilding and to accelerating the development of computer equipment, instrumentmaking, electrical equipment and electronics as catalysts of scientific and technical progress."[1]

During the current five-year plan period, machinebuilding, including the machine-tool and toolbuilding industry, which provides it with the basic industrial equipment, is being developed at a faster pace than the country's industry as a whole, in accordance with decisions of the 26th CPSU Congress and subsequent plenums. The systematic growth of the machinebuilding complex's production, scientific and technical potential and the rise in its share of the fixed production capital of all industry should be noted as an extremely positive result. A characteristic trend is the increase in the latter of the share of expenditures on operating machines and equipment, that is, the active portion of the capital. It was 36.1 percent in 1975, 48.6 percent in 1983.

The USSR is one of the world leaders in output of machine tools and equipment, and also in the installed machine-tool pool. The national economy is constantly being augmented with progressive metalworking equipment, including NC machine tools, machining-center type multiple-operation machine tools,

[1] PRAVDA, 24 April 1985, page 1.

and automatic lines. During 1981-1983 alone more than 760,000 units of metalworking equipment, including 32,000 NC machine tools, came into the national economy. Two thousand five hundred eighty sets of automatic and semiautomatic lines were manufactured for machinebuilding and metalworking.

Production of metalworking equipment is marked by the following data:

Equipment	Years				
	1975	1980	1981	1982	1983
	(in thousands of units)				
Metal-cutting machine tools..........	231	216	205	195	190
NC metal-cutting machine tools.	5.5	8.9	10.1	10.6	11.4
Forging and pressing machines........	50.5	57.2	57.1	57.3	57.5

Some of the reduction in the production of metal-cutting machine tools (in numbers of units) in recent years is associated with the conversion to the output of more progressive and complicated models, which are equipped with modern automated-control systems, the newest electric drives and other outfitting accessories. The average cost of one manufactured machine tool rose from 8,800 rubles in 1980 to 11,600 rubles in 1983. A similar trend is observed also in other industrially developed countries: a certain reduction in the total number of machine tools produced and the conversion to more complicated and productive models occurs, and, as a result, the models are more expensive. For example, in Japan the average cost of a machine tool rose during this period from $17,100 to $21,100.

The biggest national-economic problem is to create conditions for constantly improving the metalworking equipment pool. Along with augmenting it with new equipment, a number of steps must be taken to update obsolescent and worn machine tools and other machinery. In so doing, the coefficient of replacing them should be raised considerably.

The problem of rational use of the machine tool pool is become especially severe. "Another reserve, which should be exploited decisively," the April 1985 CPSU Central Committee Plenum stated, "is the drive against wastefulness and losses. The managers of many ministries and enterprises strive to 'beat out' of the state ever more capital investment, machine tools and other machinery, raw materials and fuel. At the same time they are often irresponsible in making rational use of them. The existing equipment is sometimes inactive or is used in less than full measure."[2]

A survey conducted by USSR TsSU [Central Statistical Administration] on 17 May 1984 at enterprises of 11 machinebuilding ministries revealed the following picture. The shiftwork factor was 1.38 for all metalworking equipment, including 1.47 for equipment used in basic production, 1.17 for that used in auxiliary production, while the share of nonworking equipment was 13.6 percent for all of that installed, including 12.8 percent for basic-production equipment. The use of certain progressive types of metal-cutting machine tools improved over 1983. Thus, the shiftwork factor for NC machine tools increased from 1.34 to 1.44. However, for all metalworking

[2]PRAVDA, 24 April 1985, page 1.

equipment as a whole, the shiftwork factor was below the goals called for by the five-year plan.[3]

Not one of the ministries surveyed reached five-year plan goals for this indicator. The situation was best in Mintyazhmash [Ministry of Heavy and Transport Machinebuilding], Minpribor [Ministry of Instrument Making, Automation Equipment and Control Systems] and Minselkhozmash [Ministry of Tractor and Agricultural Machine Building]. For NC machine tools the highest shiftwork factor was reached at Minenergomash [Ministry of Power and Electrification] and Minstankoprom [Ministry of Machine Tool and Tool Building Industry], the lowest at Minzhivmash [Ministry of Machine Building for Animal Husbandry and Fodder Production], Minselkhozmash and Minavtoprom [Ministry of Automotive Industry] enterprises.

In the effort to raise the shiftwork factor, the experience of Minstankoprom's Ivanovo Machine-Toolmaking Production Association imeni 50-Letiya SSSR in the use of specially made equipment in three-shift operation under a continuous workweek merits attention. The association is specialized in producing modern NC metalworking machine tools on a high technical level, as well as multiple-operation machine-center machine tools and versatile automated production modules and systems.

The output of this machinery, which is still in extremely short supply, can be expanded greatly where three-shift operation and a continuous workweek is introduced for personnel who service this specially produced equipment (since right now this is the bottleneck). This would enable its shiftwork factor to be raised from 1.8 to 2.7. By way of experiment, it is planned to introduce an incentive (pay increment) for the long service in the amount and procedure called for in the case of USSR Ministry of Light Industry enterprises for those who work on this specially produced equipment in a three-shift operation under a continuous workweek.

Use of the Ivanovo Machine-Toolmaking Association's experience will, in our view, enable metalworking equipment (primarily progressive equipment) utilization to be improved and the shiftwork factor of its operation and its yield on capital to be greatly increased.

With a view to making rational use of material and equipment resources, the attitude toward machine tools and other machines that are stored in enterprise warehouses and at facilities under construction should be changed radically. Order and discipline must be imposed in this matter and responsibility increased. According to 1 January 1985 inventories the national economy's stored residuals were counted at more than 34,000 metal-cutting machine tools, including 11,500 that were surplus for those enterprises and construction projects at whose warehouses they were stored; more than 18,500 forging, pressing and casting machines, of which 5,000 were surplus; and 389 sets of automated and semiautomated lines. And, at enterprises of the 11 machinebuilding ministries that were surveyed, there were more than 18,500 metal-cutting machine tools and forging and pressing machines (a surplus of about 7,000); and 2,918 casting machines (549 were surplus). In the face of the tense situation in manufacturing automated and semiautomated lines, there were 327 items worth 224 million rubles in the warehouses.

[3]Calculations indicate that the additional worktime saved just by achieving the average shiftwork factor (1.47) planned for 1984 could have been equivalent to releasing metal-cutting machine tools equal in number to half a year's output in the national economy.

It must be noted that the ministries that are customers for the equipment and USSR Gosplan and USSR Gossnab, when determining the requirement for machine tools and other machinery and the distribution thereof, do not analyze adequately the state of affairs in regard to stored residues and do not display proper attention to the composition of the ordered equipment and to the use of equipment on hand. Ministries and associations (or enterprises) do not consider the progressiveness of requisitioned metalworking machine tools and their potential for using advanced forms of work organization and production control. The level of specialization in the production of blanks is not adequate in the country, a situation that does not enable automated forging and pressworking machines to be used widely. At enterprises the economic incentives for introducing new machine tools and other machinery into operation more rapidly and for accelerating the updating of existing metalworking equipment pool are poor. There is also an absence of responsibility for the timeliness and quality in the delivery of unassembled machine tools that are called for by state plans for economic and social development.

The State Consultancy Commission on Questions of the Distribution and Utilization of Metalworking Equipment in the National Economy (GEKM) was formed in order to improve the use of equipment and interindustry coordination in this area, to analyze the requisitions of the fund administrators and the structure of the pool of metalworking machine tools and their use. Its task is to check the validation of ministry, agency and Union-republic council of ministers requisitions for metalworking equipment and issuance of the corresponding conclusions to USSR Gosplan and USSR Gossnab. In so doing, the objective is to send new and progressive equipment primarily to the machinebuilding and metalworking industries, while satisfying the requirements of repair departments and sections and the workshops of nonmachinebuilding ministries and agencies basically by transferring to them machine tools and other machines that have been released by enterprises of the first category after they have been repaired and modernized.

The GEKM's functions include: organization of the conduct of consultancy for the mix of metalworking equipment called for by the designs for the construction of new enterprises or for the rebuilding, expansion or reequipping of existing ones;

analysis and development of recommendations for improving the use and the structure of the machine-tool pool; and

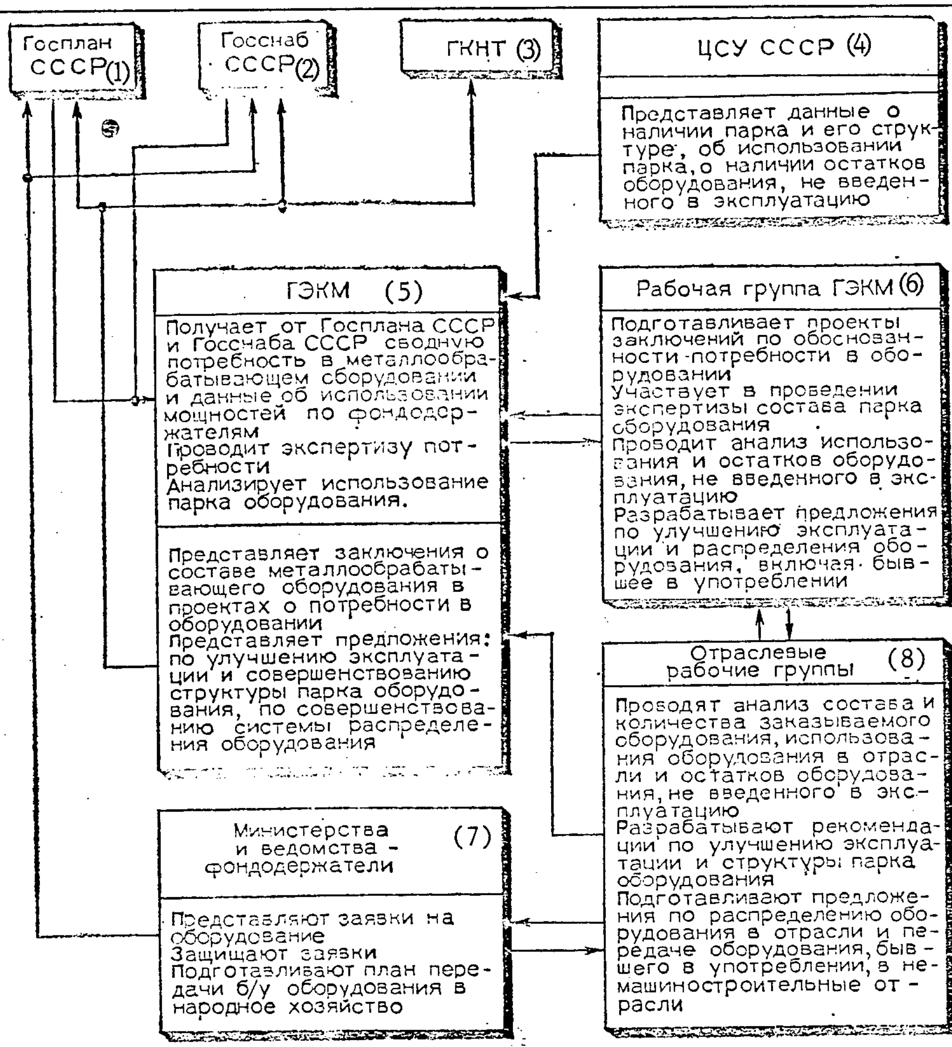
preparation of proposals for improving the system of distribution of metalworking equipment in the national economy, including those in greatest demand.

In order to prepare papers to be presented for examination and to solve some problems, a GEKM working group has been formed within the commission, to be made up of leading specialists of the machinebuilding ministries who have high qualifications in the area of machinebuilding technology. Similar groups have been established and are functioning in practically all branches of the national economy and in a number of Union republics.

The State Consultancy commission hears the reports of the GEKM working group and of supervisory workers of ministries, agencies, scientific-research, design, design-development and technological organizations on matters of using

and improving the structure of metalworking equipment in the national economy. When necessary, it can involve scientific, technical and design organizations in analysis of the use of the machine-tool pool, the preparation of recommendations on rational distribution of the equipment, improvement of the system of orders, and so on.

The basic mutual relationships of the commission with ministries and agencies are presented in the diagram.



Key:

1. USSR Gosplan.
2. USSR Gossnab.
3. GKNT [State Committee for Science and Technology].
4. USSR TsSU [Central Statistical Administration].

   Presents data about the existence of the pool and its structure, utilization of the pool, and the existence of equipment residuals that have not been put into operation.

5. GEKM [State Consultancy Commission on Questions of the Distribution and Utilization of Metalworking Equipment in the National Economy].

Receives from USSR Gosplan and USSR Gossnab the consolidated requirements for metalworking equipment and data on capacity utilization by fund administrator.

Conducts consultancy review of the requirements.

Analyzes utilization of the equipment pool.

Presents conclusions about the composition of metalworking equipment in drafts about equipment requirements.

Presents proposals for improving the operation and perfecting the structure of the equipment pool and improving the equipment distribution system.

6. GEKM Working Group.

   Presents drafts of conclusions on validity of equipment requirements.

   Participates in conducting consultancy on composition of the equipment pool.

   Analyzes the utilization and the residues of equipment not put into use.

   Develops proposals for improving the operation and distribution of equipment, including used equipment.

7. Fund-Administering Ministries and Agencies.

   Present requisitions for equipment.

   Defend the requisitions.

   Prepare plans for transferring b/u [used] equipment to the national economy.

8. Branch-of-Industry Working Groups.

   Analyze the composition and quantity of equipment ordered, utilization of equipment within the industry and the residues of equipment not put into operation.

   Develop recommendations for improving the operation and the structure of the equipment pool.

   Prepare proposals for distributing equipment within the branch and for transferring used equipment to nonmachinebuilding branches of the economy.

GEKM has analyzed the progressiveness of equipment (forges, presses and metal-cutting equipment) requisitioned for 1985 by the main machinebuilding ministries (table 2).

The following was found in regard to the various ministries. Minavtotrans greatly increased (in comparison with 1984) the requisitional requirement for metal-cutting machine tools, both in regard to the amount ordered and to the groups of progressive equipment. However, in regard to the long-term indicator,[4] the level of progressiveness of this equipment was 54.1 percent. In 1985 orders for special and ganged machine tools were reduced: Minenergomash by 80 percent, Minelektrotekhprom [Ministry of Electrical-Equipment

[4]Indicator of progressiveness of the structure for equipment established for the year 2000.

Table 2

Ministries	Amount of progressive equipment, percent of total order	
	Metal-cutting machine tools	Forging and press-working equipment
Ministry of Tractor and Agricultural Machine Building.......................	34.6	33.0
Ministry of Automotive Industry...........	29.2	12.4
Ministry of Construction, Road and Municipal Machine Building..............	32.4	14.6
Ministry of Electrical-Equipment Industry.	22.2	7.9
Ministry of Instrument Making, Automation Equipment and Control Systems...........	29.3	22.5
Ministry of Machine Tools and Tool Building..............................	62.0	9.8
Ministry of Heavy and Transport Machine Building..............................	25.6	10.8
Ministry of Power and Electrification.....	29.1	15.6
Ministry of Chemical and Petroleum Machine Building..............................	16.9	12.8
Ministry of Machine Building for Light and Food Industry and Household Appliances..	24.0	11.0
Ministry of Machine Building for Animal Husbandry and Fodder Production.........	51.9	17.4

Industry] by 63 percent, Minkhimmash [Ministry of Chemical and Petroleum Machine Building] by 45 percent, Minlegpishchemash [Ministry of Machine Building for Light and Food Industry and Household Appliances] by 41 percent, Mintyazhmash by 40 percent, Minzhivmash by 37 percent and Minpribor by 30 percent. At the same time these ministries' requisitions for NC equipment rose. Minstankoprom, while reducing the requisitioned requirement for equipment as a whole, increased its orders for NC machine tools by 30 percent and for machining centers and robotized complexes 2-fold.

An analysis of the progressiveness of requisitioned forging and pressing equipment indicates that only two ministries--Minselkhozmash and Minstroydormash--have increased their orders for automated types of equipment. In the orders of the other ministries, forging and pressing equipment in automated versions comprises 2-6 percent (Minenergomash 5.8, Minelektrotekhprom and Minlegpishchemash 5 percent, and Mintyazhmash 3 percent) and progressive equipment comprises 9-25 percent. Some ministries ordered practically no such equipment in 1985. Thus Minpribor's requisitions contained no NC machines or robotized complexes for forging and pressing machines. Minzhivmash ordered only 3 in the automated version, versus a total requirement of 180. Minavtoprom ordered only 2 percent of the more than 2,000 automated versions of general-purpose forging and pressing machines requisitioned.

On the whole, the structure of the requisitioned requirement for forging and pressing equipment cannot be called satisfactory. It does not correspond to the structure of its production at Minstankoprom enterprises, which is oriented to an annual increase in the output of progressive automated machines.

GEKM is now developing, jointly with USSR Gosplan, USSR Gossnab, GKNT, USSR TsSU and the fund administrators, proposals for improving the system for distributing and using metalworking machine tools in the national economy.

For these purposes it is necessary, in our opinion, to survey progressive metalworking equipment that is in operation and prepare measures for raising its reliability and efficiency. Since many fund administrators have substantial above-norm residues of uninstalled and surplus metalworking equipment, measures are to be taken to bring them up to the standards therefor, even in auxiliary production.

Many enterprises (as the survey results testify) have large reserves of uninstalled machine tools and other machines which have not been used for years and are obsolete. Therefore, the ministries and agencies must each year systematically analyze reserves of new uninstalled metalworking equipment that is in the warehouses of subordinate enterprises and construction projects, and determine the dates for erection, paying special attention to above-norm residues, and present to USSR Gosplan the specifications of equipment that will not be turned over for installation within the next 2 years (except for special equipment).

Ministries should examine the technological portion of designs for new plants and the expansion of existing ones that were developed and approved prior to 1981 and make changes in the structure of the operating equipment. It is desirable to conduct a selective consultancy review of the more significant comprehensive designs for enterprises of the main machinebuilding ministries in regard to the progressiveness level of the metalworking machine tools and other machines incorporated therein. Monitoring of the justification of ministry and agency requisitions for the purchase of imported equipment should be intensified, taking into account conformance of the delivery dates with plans for introducing production capacity.

Eventually, metalworking equipment should be distributed only on the basis of progressive norms and standards, where it will be used with weffectiveness. Technical-norms documentation must require that the distribution of metalworking equipment resources take into account the high-priority allocation of new machine tools and other machinery to the machinebuilding branches. It is especially necessary to allocate equipment for updating the pool, including the replacement of equipment that is worn or obsolete.

Examination by the State Consultancy Commission on Questions of the Distribution and Utilization of Metalworking Equipment in the National Economy will enable the following suggestions to be introduced:

that the basic volume of metalworking equipment be distributed in concentrated fashion on the basis of confirmed designs for the construction of new enterprises and the expansion or reequipping of existing ones; that the 12th Five-Year Plan call for a rise in the percentage (by at least 5-5.5 percent) of updating of worn and obsolete metalworking equipment;

that during the 12th Five-Year Plan, all progressive equipment produced (automated and semiautomated machines, special and ganged machine tools, automated lines, NC machine tools and other machines, including flexible production modules) be sent mainly to machinebuilding-complex enterprises;

with a view to increasing incentives for enterprises to acquire and use new, highly effective metalworking equipment (automated and semiautomated lines, NC equipment, GPS's [flexible production systems], robotized complexes, and so on), it is desirable to establish a procedure under which customer enterprises will, during the first 4 years of their operation, make amortizing deductions under reduced standards and raise the amortization charges at least 1.5-fold for obsolete and worn machine tools and other machines that are in operation; and

that authorization be granted to attribute losses from the elimination of metalworking and casting machine tools and other machines that have not been fully amortized not to the results of the enterprise's economic activity but to a reduction of the authorized inventory, as was done prior to 1980.

In order to accelerate the introduction of equipment into operation and to reduce residues in storage, authorization to redistribute unused equipment, including that which has been outfitted by USSR Gossnab's Soyuzglavkomplekt [Main Administration for Outfitting Especially Important Construction Projects of the Coal, Oil and Other Branches of Industry with Equipment, Instruments, Cable and Other Items], with later compensation to the fund administrators' thereof, is justified.

All machinebuilding ministries must develop for the 12th Five-Year Plan period industrywide programs for raising utilization effectiveness of the metalworking equipment pool.

As the CPSU Central Committee meeting of 11-12 July 1985 stated, the party is viewing a drastic speedup in scientific and technical progress as the main level for intensifying the national economy, referring here not to improving existing technologies or to partially modernizing machines and equipment, but to converting to basically new technological systems, to new-generation equipment that will yield the highest effectiveness. And the technical policy for improving the structure of machinebuilding's technological-equipment pool will be executed on that basis.

11409
CSO: 1823/241

INDUSTRY PLANNING AND ECONOMICS

GROWTH OF MACHINE TOOL INDUSTRY IN UZBEKISTAN REVIEWED

Tashkent EKONOMIKA I ZHIZN in Russian No 10, Oct 84 pp 33-35

[Article by L. Rublev: "The Leading Role of Technical Progress"]

[Text] A multiple-branch industry equipped with the newest technology was essentially created anew in 60 years in Uzbekistan. Socialist reconstruction of the republic's economy was accomplished on the basis of heavy industry. Back in 1940 industrial production volume rose 12-fold in comparison with 1924's.

The new branches of industry born during the war enriched and successfully augmented the industry that had been established prior to 1941, and they became an excellent base for further economic development. Production volume has grown immeasurably. During the 9th Five-Year Plan, industrial output averaged 11.9 billion rubles worth annually, 16.1 billion rubles during the 10th Five-Year Plan and 19.5 billion rubles during the current five-year plan.

Let us visualize a platform where all types of products produced in Uzbekistan are displayed. It would be enormous. The economy has tens of different industries in the republic. But the greater part of the exposition would be that devoted to machinebuilding and metalworking products. Statistics define their share precisely--15 percent of the gross product of the republic's industry.

A list of products of Uzbekistan's machinebuilding enterprises would take up much space. The branch's output is sent all over the whole country and to many foreign addresses. But still it should be noted that, in the All-Union labor breakdown, Uzbekistan emerges as primarily a high-capacity complex for producing machinery for raising the main industrial farm crop--raw cotton.

...It all started from scratch. The USSR Council of People's Commissars on 17 May 1928 proposed that the Uzbek SSR SNK [Council of People's Commissars]: "study carefully the matter of organizing in the Uzbek Soviet Socialist Republic a network of machine shops for producing the simplest agricultural implements."

It was the 11th year of the October Revolution, the 4th year of the Uzbek Republic. Vast social and political changes had occurred in the former semicolonial district of Tsarist Russia, only economic change remained to be accomplished. Colossal work still lay ahead.

The establishment and accelerated development of machinebuilding are unforgettable pages in Uzbekistan's history. And how can it be possible to forget the brightest fact--the creation, within 2 years, of the firstling of our farm machinebuilding, the Tashselmash plant. This figure testifies eloquently to the unprecedented pace of prewar building: in 1940 machinebuilding and metalworking had increased 62-fold over the year the republic was proclaimed. The republic's economy had successfully converted to the rails of socialist industrialization.

Indeed, the years of the Great Patriotic War, when tens of plants were evacuated from the country's west to our district, are growing dim in memory. Production of output began in mere weeks in departments that did not have roofs, and sometimes even walls. Nowadays the widely known Uzbekkhlopkomash, Chirchikselmash, Podyemnik, Kompressor, Tashtekstilmash, a tool plant, an abrasives combine, an electronics-equipment plant, and an aviation, cable and tens of other plants have taken on a second life on Uzbek soil.

In the postwar period, machinebuilding and metalworking have been developed with still greater intensity. In comparison with 1940, output volume increased 220-fold in 1965. And during the 8th and 9th Five-Year Plans it grew 2.6-fold. It was then that the republic began to produce many new types of products--tractors modified for cotton, cars for bulk hauling of raw cotton, and semitrailers for trucks. The following fact, for example, will give a notion of what this means. Bulk hauling of cotton enables a saving of up to 3 rubles for each ton of the raw material, and a computation of the "white gold" harvested in the republic comes to millions of tons.

Our machinebuilding and metalworking successes are indisputable, but, in giving them their due, as V. I. Lenin taught, attention must be concentrated on an analysis of the current state of the tasks that still have not been resolved. What does the most important branch of our economy live on today?

Product quality is the most important indicator of the work of any enterprise, but it plays an especially great role in machinebuilding and metalworking--branches where technical progress is being born. The collective of Tashkent's Kompressor plant recognizes this truth well. Its output is used in all parts of the Soviet Union, and it is sent to many foreign places. And it must be noted that the factory's workers, after spending much effort on the work, saw to it that the assemblies with the Tashkent brand ceded but little to the best world models. Up to 90 percent of its compressors bear the Emblem of Quality.

Kompressor was awarded the challenge Red Banner of the CPSU Central Committee, the USSR Council of Ministers, the AUCCTU and the Komsomol Central Committee for its successes. Yet the collective still will not rest on its laurels, but will seek out and use deep production reserves and improve work organization.

The Podyemnik plant, which was evacuated from Moscow in the threatening year of 1941, had already produced 20 overhead-traveling cranes in 1942. This

was a great victory. In the 42 years of its stay on Uzbek soil, the plant's capacity has risen 70-fold. It was one of the republic's first enterprises to enter into the path of a wide-scale economic experiment. During it, labor productivity grew, prime production costs were reduced and, the main thing, deliveries discipline was improved. The monetary incentive fund for the enterprise increased 15 percent during the first quarter of this year under the terms of the experiment for successfully meeting the plan for delivering output. Workers, engineers and technicians were clearly convinced that a rise in regularity of the work pace and unswerving fulfillment of state tasks would result in genuine benefits.

The complication of production and augmentation of the equipment pool are causing improvement in production management, based upon a system worked out with precision, to become first priority. This is confirmed in the activity of a number of machinebuilding enterprises. Introduction of the Unified System of Engineering Preparation for Production is yielding a good return at the association's Uzbekkhlopkomash plant and at the Tashselmash and Uzbekkhimash plants. It enables utilization effectiveness of the machine-tool pool to be raised, interdepartmental relationships to be improved, and the rhythmicity of production to be raised.

However, affairs are far from being the same at all the republic's enterprises. Let us take, for example, the Sredazkabel Production Association. It produces much-needed output, and it is, in particular, the country's sole producer of trolley wire. Therefore, very important work on railroad electrification and the laying of new trolley lines in many cities of the Soviet Union depend upon it. But Sredazkabel is operating extremely erratically.

The line for continuous castings and rolling at Sredazkabel was idle for almost 3 months because the sole melting furnace had gone out of commission and the enterprise had no reserve.

Now the malfunction has been eliminated, but costly time has been lost, and many orders have been delayed. Indeed, there is nothing more difficult than to catch up, to cover one's arrears. The enterprise is working feverishly.

The situation in regard to product quality is far from favorable. The honorary pentagon goes to only 62 percent of the output, for production is taking place under highly intensive conditions, where stopping to replace cable items that have got out of order is fraught with grave consequences.

Uzbekistan's machinebuilding and metalworking enterprises have at their disposal rich basic production capital, which grows from year to year. But do we always manage it economically? The statistics give a negative answer to this important question. Let us take, for example, such an indicator as the shiftwork factor. At some enterprises they accord it, as they should, paramount attention, correctly assuming that the longer the equipment operates the higher the production rate and the more actively that production progresses without additional capital investment. Thus, at the industry's largest plant--the tractor plant--the shiftwork factor is 1.64. It is high also at Chirchikselmash. But for Uzbek enterprises as a whole, this figure is far from what is desired.

Automatic lines are being used increasingly widely at the industry's plants. But it is not being used with adequate effectiveness. The shiftwork factor, which had not achieved the desired results, has been reduced in recent years, and at present it is 1.4. The indicator is low for equipment that is intended to work two or more shifts.

Steady forward motion is the very first law of the machinebuilding industry. Meanwhile, it is far from being fulfilled everywhere.

A typical example of that are the cotton harvesters produced by Tashselmash. Their arrival in the field at one time marked a radical revolution in the mechanized technology for cultivating cotton and enabled production of the "white gold" to be increased and the time spent harvesting it to be cut. The people assessed highly the work of the machines' creators. The plant's work was recognized with two government awards.

But time does not stand still. Right now agricultural workers are more often criticizing the machines' quality, which does not meet the rising requirements.

The driver's place, which is poorly adapted to the working conditions, provokes especially many justified reproaches. In essence, it does not have even a primitive cab. A piece of cloth fastened over his head--that constitutes all the operator's "conveniences."

In a short time the cotton-harvesting machine will get a more powerful engine, which the Tashkent Engine Plant, now being built with vigor, will begin to ship. It is necessary to resolve just as vigorously the problem of producing a convenient and comfortable cab for the harvester. The rise in the driver-operator's labor productivity will more than repay the added costs.

The end of the current five-year plan is getting close. Machinebuilding and metalworking workers of Uzbekistan, together with all the Soviet people, should use effectively the remaining time to complete it successfully and to create a strong foundation for further successes. The April 1948 CPSU Central Committee Plenum and the decisions of the 16th Uzbekistan Communist Party Central Committee Plenum, which required a decisive struggle with existing negative phenomena in Uzbekistan's economic life, is guiding the machinebuilders toward this end.

11409
CSO: 1823/043

QUANTITY OF MACHINING CENTERS, QUALITY OF CONTROLLERS LACKING

Moscow TRUD in Russian 12 Jul 85 p 2

[Interview with N.A. Panichev, first deputy minister, Ministry of the Machine Tool and Tool Building Industry, by A. Pankov, TRUD special correspondent; date and place not specified: "Acceleration Policy"]

[Text] Key sectors in scientific and technical progress such as machine tool building will play an especially important role in accomplishing the task put forward at the April 1985 plenum of the CPSU Central Committee and meeting of the CPSU Central Committee concerning rapid re-tooling of the entire national economy. Our special correspondent interviewed the first deputy minister of the Ministry of the Machine Tool and Tool Building Industry, N.A. Panichev, about the technical level which has been obtained and plans for accelerating improvement.

[Question] Now that one five-year plan is drawing to a close and plans are being made for the next five-year plan, the party is preparing for its regular congress and higher demands are being placed on every sector, a thorough analysis of the current state of affairs and a sober evaluation of accomplishments are needed. A comparison must be made not only with the immediate past, but also with what remains to be done and better foreign systems. Mr. Panichev, in what areas is the sector successfully competing with foreign firms, and in what areas is our sector lagging behind world standards?

[Answer] A number of our enterprises' products could be mentioned that are in demand abroad, for example, some unique heavy lathes are being bought by Japan, Italy and Canada; heavy forge press machines, turning lathes, grinders and other lathes are also being exported.

However, we have to incorporate imported control systems and components into automated equipment manufactured by a number of enterprises in the sector. We are still lagging in systems assemblies and parts required to automate machines.

[Question] What are the reasons for the lag?

[Answer] The main reason is the unreliability of automated devices, as a result of which the over-all technical level of machine-tool, casting and forge press equipment is considerably lowered. In this area, we need extensive

assistance from the Ministry of Instrument Making, Automation Equipment and Control Systems, the Ministry of the Electronics Industry, and the Ministry of the Electrical Equipment Ministry.

[Question] Your ministry is both producer and consumer of new technology. What difficulties have you experienced as a consumer of machine-builiding production?

[Answer] I have already mentioned the reliability of control systems. In addition, the quantitative aspect should be mentioned: there is a shortage of automatic and automated equipment, including machining centers and flexible manufacturing systems, finishing equipment, especially grinding and jig-boring machines. But the main problem is integrated automatic machining systems for multi-technological processes involved in the machining of standard machine-building products for both batch and mass production.

[Question] So as a consumer, you feel that you are dependent on machine builders. What has already been done and what remains to be done to eliminate the lag behind world level standards and growing demand of the national economy?

[Answer] The task is this: provide the machine-building industry with portable, high-productivity, automated technological equipment to step up production without hiring additional workers.

The volume of automated-equipment production has greatly increased in this five-year plan. By 1990, the growth rate will be even higher. In the 12th Five-Year Plan, annual production of numerically controlled machines, including multi-operation flexible-production centers, flexible manufacturing modules, robotized complexes, flexible production systems, automated forge-pressing equipment and automatic casting complexes, will be greatly increased. We will also be given the task of increasing accordingly the average productivity of metalworking lathes and forge press machines by a factor of 1.8 and casting equipment by a factor of 1.7. Accomplishing this task will free a large number of workers and save state resources.

[Question] Can one talk about saving if some factories are showing losses on expensive modern equipment?

[Answer] It is true that when one or two numerically-controlled machines or an industrial robot is acquired by a shop, there are not always profits and there may even be losses. We are convinced on the basis of experience of many enterprises, both in the USSR and abroad, that considerable progress is still made in the process of making complex technological decisions. This is inherent in scientific and technical progress in batch production in machine building.

The Congress of the CPSU Central Committee was correct about accelerating scientific and technical progress in that first of all, we must readjust psychologically. The fact that there are problems connected with the utilization of new equipment does not mean a return to old equipment and technology.

[Question] Undoubtedly, psychological readjustment is necessary because many industrialists have become accustomed to being satisfied with the status quo,

not bothering themselves with unnecessary concern for retooling production and conversion to the manufacture of modern products. But the psychological aspect seems minor: a solid technological base is also needed. You mentioned a sharp increase in the production of the latest equipment. But how will quality be improved?

[Answer] First, by rebuilding existing enterprises. We are concentrating our efforts on the technical re-tooling of 51 factories, which is one sixth of the ministry's enterprises. We are scheduled to spend two-thirds of our entire funding on the development of the sector. Production at these factories will be completely retooled in order to produce the latest automated equipment. Of course, the construction of new factories is still planned, particularly for the repair and up-dating of metalworking equipment. Regional centers for servicing numerically controlled lathes and flexible manufacturing systems will also be set up. Improvement will doubtless reach all remaining enterprises. All this, in addition to what has already been done, will make it possible to increase the sector's labor productivity by a factor of more than 1.5.

[Question] What share of total production will be comprised by state-of-the-art equipment by the end of the next five-year plan?

[Answer] Special and modular machines will comprise over 30 percent, precision equipment will comprise over 15 percent, and numerically controlled machines will comprise about 16 percent. Forge press machines containing automated and power components will comprise 29 percent.

[Question] Will this meet our demand for machine construction?

[Answer] No, it will not. The ministry has formulated a proposal to increase the production of machining centers significantly in order to bring annual production volume up to 9,000. This will meet the demand of all sectors and release about 100,000 workers to the national economy.

[Question] What is being done in the sector to increase the output of equipment using modern physics and chemistry: laser and ultrasound machining, plasma spraying, etc.?

[Answer] The sector's main institute, the Experimental Scientific Research Institute for Machine Building, in Moscow, is actively involved in developing lathes using electrophysical machining methods. Some of our plants in Troitsk, Kirovakan and Kaunas are producing this equipment. Lasers are now drilling holes, cutting shaped parts and tempering. Machining centers using electrophysical devices will be developed in due time.

The Voronezh Experimental Research Institute for Forge Press Machine Building is developing laser presses to cut sheet metal. The All-Union Designing and Planning Institute for Welding Equipment in Kiev is the sector's main institute for plasma-sprayed machine parts. We are still not manufacturing enough plasmatrons. We are going to consider increasing production.

[Question] Why is the ministry not manufacturing high-productivity highly recommended equipment such as rotary lines?

[Answer] It cannot be said that we are not manufacturing any. But it is true that we are not manufacturing many. The main reason is that rotary lines are more appropriate for mass production and operations where there are little or no chips, such as stamping, forging, casting and assembly.

[Question] But stamping and casting are operations which have a promising future, because they greatly reduce chips. The ministry is faced with the problem of reducing material requirements while it continues to produce too many heavy lathes and not enough equipment for low-waste technology. What is being done to solve this serious problem?

[Answer] Our institutes and design bureaus have been given the task of devising materials, designs and technologies to make lighter, more handlable lathes. Plastic is being used more than metal. The Leningrad Precision Lathe Association and the Orshanskiy Krasnyy Borets factory have done quite a lot in this area. A plan to rebuild our casting capability is being formulated.

Of course, it is more important to produce more machines that make blanks closer to final dimensions. The Experimental Research Institute for Forge Press Machine Building, for example, has developed radial cogging mills. This is a step toward low-waste technology.

[Question] The reliable operation of modern automated unmanned or nearly unmanned equipment requires especially hard cutting tools which retain their sharpness ....

[Answer] Yes, reliable tools are one of the main prerequisites for automation. We are formulating a program for improving the quality of cutting tools. There are several ways to do this. The most common way is to use man-made super-hard materials such as Elbor, Hexanite and synthetic diamonds. Tools made of traditional materials such as hard alloys and quick-cutting steel can be made harder. Case hardening by spraying metal powder can double or triple tool hardness. We hope to case harden all tools soon in special facilities.

[Question] Are you satisfied with the performance of the sector's scientific research institutes and design bureaus? Are any measures planned to enlarge their part in accelerating scientific and technical progress?

[Answer] The state of our science is being evaluated very severely after the CPSU Central Committee meeting, and of course we are not satisfied with the institutes' practical results. It is now planned to set up scientific production associations in order to have a main institute with the necessary design and production base to service each basic trend in machine building and the machine tool industry. At the same time, we intend to set up an experimental base for the institutes, apply automated design systems more widely and greatly raise the level of automation of designing services and the technological support of production.

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CURRENT UTILIZATION OF FORGE-PRESS TECHNOLOGY SURVEYED

Moscow EKONOMICHESKAYA GAZETA in Russian No 31, Jul 85 p 2

/Article: "Technical and Economic Survey: Low-Waste Technology Resources"/

/Text/ Pressure machining methods allow one to obtain blanks and parts of the most diverse configuration, weighing from a fraction of a gram to hundreds of tons. Forge-press machines provide, to an ever greater degree, a low-waste technology for obtaining not only blanks but also finished parts which either do not require further mechanical machining or require only negligible finishing work. The scope is growing of using manufacturing methods to press plastics, abrasives, synthetic diamonds, chip and wood-fiber boards, peat briquettes, and cotton bales.

The pressure machining of metals and other materials is one of the most effective types of resource-saving technologies. In today's motor vehicle production, for example, from 60 to 70 percent of the parts are made by the cold sheet-metal stamping method and their labor-intensiveness amounts, on the average, to 6-9 percent of the total labor expended to manufacture motor vehicles. It is no accident that a June conference in the CPSU Central Committee listed a sharp increase in KPO /forge-press equipment/ production among the decisive factors in re-equipping the machine building industry.

Small-scale superhigh pressure presses and modern forging machines, which significantly reduce metal waste materials in machine building, were among the most successful scientific and technical developments mentioned at the conference in the CPSU Central Committee.

At the present time, the growth in the output of forgings and stampings is lagging behind the increase in rolled metal production. As a result, the negative tendency of the predominance of machining by cutting remains which, as is well known, is linked with the production of a large amount of metal shavings.

The production of forge-press machines has been increasing by 29.2 percent in the country during the years of the 11th Five-Year Plan. In 1985, 53,600 machines must be manufactured at a cost of 702 million rubles, including 40,000 machines at a total cost of 633 million rubles by Minstankoprom/Ministry of the Machine Tool and Tool Building Industry/ enterprises.

For example, the building by the Voronezh Association for the Output of Large Mechanical Presses, jointly with the association "Avtozil," of an automated line for the low-waste stamping of crankshafts and front axle beams for the ZIL/Moscow Motor Vehicle Plant imeni I. A. Likhachev/-130 motor vehicle is an example of an important achievement of domestic press building. The line is based on one of the largest crank die-forging presses in the world which has a force of 12,500 tons. This line permits a 1.5-fold increase in labor productivity, decreases metal expenditure by 15-20 percent, and saves 3,500 tons of metal a year when stamping crankshafts alone.

Such data testify to the effectiveness of improving KPO output structure. More than 1,780,000 tons of metal have been saved during the years of the five-year plan nearing completion because of the output during 1981-1985 of 10,000 units of forge-press equipment which carry out 11 progressive manufacturing processes (the accurate cutting of rolled metal for blanks, cold upsetting and spinning, radial shingling, flashless die forging in split starting sheets, pressing metal powders, etc.). For example, the use of radial shingling machines for crankshafts increases metal use of capacity to 0.9 compared to 0.51 when they are manufactured on lathes.

It should be kept in mind that the total results presented above were calculated based on manufacturing processes developed by industry which were effective but which were known about for a long time. We could add to this the large reserves connected with the latest manufacturing methods, e.g., the use of the phenomenon of metal superplasticity and superhigh static and dynamic pressures discovered by domestic science, and the use of laser equipment and other means to intensify machining in KPO.

Both the growth in KPO productivity and the improvement in its operating conditions depend directly on increasing the level of automation.

Various types of automatic machines and automated lines, which are being used with great economic effect to manufacture a minimal number of parts alloted to each machine, are being used successfully in mass and large-series forge-stamping production. For example, finished parts with precise contours and a surface roughness not requiring further mechanical machining are obtained on automatic machines for the finishing punching of parts from a strip and tape. Productivity is 5-8-fold higher compared with cutting. The series production of three sizes of such automatic presses--with a force of 40, 250, and 400 tons--has been started by plants of the VPO/all-union production association/ "Soyuzkuzmash" of Minstankoprom.

However, the use of automatic machines in series and small series production, where three-fourths of all machine building production takes places, is economically and technically inexpedient. Under these conditions it is necessary to keep the capability inherent in universal forge-press machines to be re-adjusted to manufacture a diverse parts list. At the same time, it is important to automate their loading and unloading and the changing of dies.

The output of automated complexes based on universal machines and equipped with means of mechanization and automation has increased 1.9-fold in the 11th Five-Year Plan. The retention of a similar dynamic should be expected in the 12th Five-Year Plan.

According to USSR Gosplan/State Planning Committee/ data, approximately 15,000 universal presses were equipped with industrial robots during the years of the 11th Five-Year Plan. The largest share, about 30 percent, of the robots produced in the country are used in forging and stamping production.

The use of programmed control in some cases permits fundamentally new qualities to be added to equipment.

Smith forging from time immemorial and up to our own time has been linked with great losses of metal, excessive allowances, and the formation of a large amount of shavings during the subsequent labor-intensive machining by cutting. This notion has been disproved by the Voronezh Experimental Institute of Forge-Press Machine Building and the Dnepropetrovsk Association for the Output of Heavy Presses. An automated equipment complex with programmed control, based on a forging hydraulic press with a force of 3,150 tons for the smith forging of a product list of blanks, is now in operation at the Kiev Production Machine Tool Association. A size accuracy of ±1.5 mm is being achieved on it. Up to 10 percent of the metal is being saved and labor productivity is growing 1.3-1.5-fold because of this increase in accuracy. Half as many blacksmiths are needed and their work conditions are improving radically.

Such smith forging, just like forging on radial shingling machines, may very rightly bear the name "precision."

Sheet-bending machines with a swivel bending beam, which have programmed control, have 1.5-fold greater productivity than without it. The worker does not have to set up repeatedly and remove the part or control the work of auxiliary mechanisms for which much time and energy is expended, especially when bending heavy parts. Minstankoprom enterprises already have in series production a range of such machines for bending sheets 1.6-6 mm thick.

The experience which has been gained permits specialists to formulate the basic directions in equipping KPO with numerical programmed control.

In the first place, there is the automation of the process for making parts whose shape and size are not formed by a tool (punches, dies) installed in a fixed position on a machine but are achieved gradually by shifting the tool when operating or changing the relative position of the blank (semifinished product) and tool. This applies to bending, leveling, and punching machines.

Secondly, there is the automation of the manufacturing process in which the quality of the parts obtained depends on a series of variable factors. In thermoplastic automatic machines, for example, this may be the regulation and control of the specific force, temperature, speed and time of injection, and soaking of the substance.

Thirdly, there is the automation of control by independent coordinates of machine mechanisms and automated complexes rather than ensuring the complicated movements of mechanisms through cumbersome, labor-intensive, not always reliable, kinematic connections. The question concerns spring-coiling and universal automatic machines and automated complexes of various kinds.

The diversified forging and stamping production products list and the continuous reduction in the time periods for changing production have placed the questions of introducing bending technology and the appropriate equipment on the agenda.

The processing center created by the Chimkent Production Association for KPO Output, which is based on a coordinate-revolving press with ChPU/numerical programmed control/ and is intended for making flat parts from a sheet during medium series, small series, and custom production can qualify as one of these newest machines. The following operations are conducted: positional punching and cutting out openings of various sizes and shapes; contour and rectilinear cutting; trimming by milling of stamped contour combs; threading punched openings.

A processing center with programmed control based on single-action, single-crank open press, with a force of 63 tons, has been built for sheet-forging in small series and series production.

The introduction of such a processing center makes it possible to increase productivity 8-fold in small series production. The time periods for technical equipping are decreased 2-3-fold, and the labor-intensiveness of making stamping equipment 3-4-fold. Equipment metallic content is decreased by 70 percent.

Minstankoprom, Minpribor/Ministry of Instrument Making, Automation Equipment, and Control Systems/, and Minelektrotekhprom/Ministry of the Electrical Equipment Industry/ have the job of sharply increasing the reliability of ChPU equipment and devices, electric drives, and electrical automation means for KPO.

A CPSU Central Committee conference emphasized that the effectiveness of new equipment depends not only on increasing its output but also on its skillful total utilization in the national economy. As applied to forged-press equipment, this means the necessity to increase the level of specialization and concentration of forging and stamping production which today is spread over thousands of enterprises. Also essentially uncoordinated is the production of forging dies, molds, and other manufacturing equipment which are being made at each enterprise through its own efforts and for its own needs. Only 15-20 percent of forging dies and molds are made at Minstankoprom specialized plants or at specialized intrasectorial enterprises of other ministries.

These circumstances hinder broadening the sphere of use of machining materials by pressure and the introduction of progressive manufacturing processes. The effectiveness of using highly-productive forge-press equipment is reduced.

The VPO "Soyuzkuzmash" has not handled the main tasks of the first six months of the year. The commodity production plan has been fulfilled by only 97.3 percent. A considerable lag has been tolerated for the most important kinds of equipment. There is a shortage of 137 KPO complexes equipped with mechanization and automation means, 84 machines with programmed control, 5 automatic lines, and 194 automatic machines.

The low quality of machines manufactured by a number of plants is causing special alarm. Users are highly critical, particularly about the quality of the powder metallurgy presses of the Pinsk Forge-Press Automated Line Plant. The press builders must not forget that the unfinished structural work and the low manufacturing quality of machines that by design are the most effective can bring all of their potential advantages to naught and undermine confidence in progressive manufacturing methods.

To make up this tolerated lag and to go out to the planned boundaries, especially for the manufacture of new, advanced equipment in the shortest time period--this is the real duty of the Minstankoprom and VPO "Soyuzkuzmash" managers.

8524
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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

UDC 65.011.56

NATIONAL PRIORITY EFFORT: ESTABLISH FLEXIBLE MANUFACTURING

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 6, Jun 85 pp 63-72

[Article by Yu. M. Solomentsev, doctor of technical sciences, and V. G. Serebrennyy, candidate of technical sciences: "Scientific Research Tasks in the Field of Flexible Automation" under the rubric: "Organization and Efficiency of Scientific Research"]

[Text] Recent years have seen the initiation of scientific research directed toward increasing the efficiency of metalworking equipment. The introduction of progressive processing methods and resources based on digital program control, industrial robots, adaptive control systems, etc., is becoming one of the fundamental tendencies in the development of this type of equipment. Current demands for rapid changeovers to manufacture new products will produce the problem of shifting machine building from the automation of individual operations and units of the production process to comprehensive automation at all levels by means of flexible and highly efficient equipment complexes.

Goals of Flexible Automation

Until this time, a changeover to the production of a new product in the machine tool industry has been seen as a unavoidable interruption between periods of normal factory operation. This changeover is usually carried out on a separate, section-by-section basis in order to prevent stoppage of the entire production process. However, even this inevitably reduces production efficiency. Flexible automation primarily provides new capabilities for creating multi-product production lines and allows rapid changes in the production/engineering relationships of active equipment within a complex and in the functions of all of its components, down to the individual machine level, in accordance with the technical and economic specifications of the products manufactured.

At present, experience has been accumulated in the USSR and abroad particularly in the development of flexible production systems for large- and medium-scale production applications. However, the course of modern technology demands continuous expansion of small-scale production. Small-scale production now makes up some 70 percent of the total volume of machine building. By now the possibilities for a significant increase in small-scale production labor productivity by means of traditional technical and organizational measures have been exhausted. This calls for the widespread development and introduction

of flexible production systems. Thus, the creation of flexible automated systems, with their capacity for further increasing efficiency, is becoming one of the critical areas in the development of all machine construction.

A combination of applied and fundamental research is required to resolve this task. In this connection we can point out the beneficial experience of cooperation between USSR Ministry of the Machine Tool and Tool Building Industry's [Minstankoprom] institutes and the Academy of Sciences USSR in carrying out joint research on machine tool building problems, as planned for the period 1981-1985.

At the present time, under the leadership of the USSR State Committee for Science and Technology, the Moscow Machine Tool Institute, the Minstankoprom's Experimental Scientific Research Institute for Machine Tools Used in Metalworking (ENIMS), the Academy of Sciences USSR's Mechanical Engineering Institute imeni A. A. Blagonravov, a number of other sector scientific research, design/manufacturing and technological organizations, institutes of the USSR Ministry of Higher and Secondary Specialized Education, and the USSR State Committee for Standards are developing an All-Union program of fundamental and applied scientific research on long-term development of flexible production systems.

The creation of a flexible production system is a complex and arduous problem which requires the interrelated resolution of tasks such as developing manufacturing processes; selecting structural and compositional design solutions; designing overall structures for machines, ancillary equipment and tools, monitoring/measurement devices, control and diagnostic systems; and, finally, organizing the operation of such systems under conditions of change in the structures of production processes carried out at the individual workstations. As a rule, a dispersed development approach does not lead to efficient technological solutions in the creation of a flexible production system and the coordination of manufacturing of its machine tools, modules, transport/storage facilities and other systems. This type of work, based on engineering intuition and the trial-and-error method, is oriented toward the stage during which a new trend is being established and allows the accumulation of required experience, but it is not efficient in widespread industrial application. The multi-unit nature of the flexible production system and the large number of production processes involved give rise to a number of possible structural and compositional solutions. An empirical selection of the single optimum solution from among these is extremely difficult. At the same time, overall system efficiency and the establishment of all fundamental system component technical specifications depend on the correctness of that choice. Since the expenditures involved in creating a flexible production system are extremely high, widespread use of less than optimal systems can lead to tremendous material losses.

Thus, as with any complex system, the most difficult and critical stages of flexible production system design take place in the early phases of development, prior to the design of specific machines and units. Incorrect decisions or errors made at this point are difficult to correct later. From this it is obvious that flexible production system design calls for broad

research on the basis of a systems approach and intense study of variations by means of modern computer equipment.

Characteristics of the Systems Approach to Flexible Production System Development

Although flexible production has already become a reality in worldwide practice, its theory is little studied and the experience gathered in the field still awaits extensive scientific interpretation. However, initial attempts at implementing flexible production have forced a change in traditional concepts of basic and auxiliary production processes and have made necessary a search for new approaches to their study and design.

Let us recall that a flexible production system is an adaptive system of machines, that is, a system with a fixed structure of components whose operating strategy can be deliberately changed by substituting component functions and forming new link structures between components. It is this property of the flexible production system which allows it to maintain high productivity when performing production tasks, even under conditions of frequent and irregular changes in the types of products manufactured, to independently maintain given production process parameters and to compensate for external and internal disturbances (material supply interruptions, task change directives, etc.) and which provides high production flexibility. System survivability, that is, its ability to remain operational when individual elements or links fail, is yet another quality of special importance in manufacturing which results from this flexibility.

Thus, while the traditional basis of machine and device development involves research into machine kinematics, dynamics, endurance, and the calculation and building of individual designs, in flexible production system development the center of interest shifts to the study of systems of machines and the laws of dynamic interaction of adaptively linked machines and aggregates.

At present the first priority must be the establishment of basic directions for such research and the creation of an overall methodology for flexible production system design which allows the elimination of a search for individual (and as a rule, less than optimal!) solutions in each specific instance. The tasks of researching, designing and completing individual machines retain their importance, but now they must be resolved using the requirements for optimum overall system operation as the starting point. Here we must fully take into consideration the fact that certain quantitative changes in the components of a complex system can give the system new qualities and the overall impact can significantly exceed the sum of the effects contained in the individual components. At the same time, an optimal system cannot by any means be created simply by assembling a number of optimized components.

It is no less important to remember that the system of machines itself operates within some higher-level system and, consequently, it must be viewed both as an autonomous unit and as a subsystem of the higher-level system by isolating all links between the two and evaluating their effects. Otherwise, gains at the subsystem level can turn into significant losses for a large system.

Partial series production automation based on automatic and specialized machine tools serves as an example of this phenomenon. Small cycle losses in these machine tools allowed a reduction in product manufacturing times, but significant time outlays in retooling led to an increase in batch production operations for more complete machine tool utilization. As a result, labor productivity rose in the automated sections, as did the equipment load factor.

At a given stage this played a positive role and enabled universal distribution of this type of approach to automation. Moreover, this approach was carried over to small-scale production and even to individual-unit production. Sections for processing technologically uniform groups of parts were established for these types of production based on group technology and process standardization. This brought the organizational form for these types of production closer to that of line-flow production. With this, however, fulfillment of the most important demand placed on a factory by the national economy--smooth output of finished products--became extremely difficult due to the appearance of a significant and, moreover, constantly changing shortage of parts for assembly.

Many attempts to introduce automated systems for the control of small-scale production, intended to provide a rational compromise between uniform production and high equipment loads through the selection of an optimal component batch size based on economic/mathematical methods and planning models, did not produce the desired effect. The conversion of production process and equipment structures necessitated by partial automation led to such organizational difficulties and complicated operational schedule planning to such a degree that factories often had to choose a "simpler" means of assuring a smooth output of finished products made up of combinations of variable types of components--the formation of parts stockpiles in warehouses.

This automation of small-scale production allowed an increase in equipment operating efficiency but there was a simultaneous reduction in overall factory efficiency due to high growth in the volume of work in process, the inefficient use of costly work space to store component surpluses, serious losses due to failure to meet affiliate assembly component delivery deadlines, etc.

The losses incurred by the national economy were tens of times greater than the individual gains resulting from this type of automation.

Scientific Problems in Pre-Design Research

The example given of the effects of a failure to consider system-wide demands in the implementation of major projects points out the fact that one of the primary scientific problems in creating flexible production systems is the formation of a complete set of indicators (quality criteria) which consider all phases of production and which allow a complete evaluation of the technical and economic efficiency of a flexible production system.

A listing of the basic indicators must be prepared by considering the system's goals for each hierarchical level and must include fundamental national economy indicators (and their limits), such as productivity, flexibility (the

time required to convert the system to production of a new type of products), reliability, economy, etc.

The optimization of goals at the lower levels, especially at the flexible production system's component and unit levels, cannot be examined as a goal in itself, but it must be primarily directed toward satisfying the requirements of the level above while not opposing the goals of the flexible production system itself (Figure 1).

Under these conditions the second most important scientific problem is the establishment of a flexible production system optimization theory and a methodology for vectored evaluation of the efficiency of the entire set of criteria formulated. A complete and comprehensive economic analysis of a flexible production system is complicated and the methods for such an analysis are not highly developed. Existing methods for evaluating the economic basis of technical solutions and estimating economic efficiency, while successfully applied in industry to evaluate comparatively simple individual measures in the introduction of new equipment, are not directly suited to solving flexible production system design problems. Problems of this type require the creation of mathematical models which allow systems analysis of structural and compositional alternative solutions and which assure the consistency of methods and evaluations in the flexible production system's design process as well as during its operational stage. This approach creates the basis for carrying out on-line economic analysis of systems in operation in order to determine an optimum control strategy during production shifts.

The next scientific problem is the development of a theory for producing optimized systems and the methods for implementing optimized technical solutions. The flexible production system must not be designed for operation under current production organization conditions. First of all, the optimum structure for a given production process must be developed by analyzing the basic functions involved; only then can the flexible production system be designed.

In its most general form, a flexible production system design theory contains a basis for selection of the product line to be processed, the type and quantity of working and auxiliary devices, means of linking these devices to obtain a production process with a given set of operational characteristics and, finally, a means of structuring component flow lines so as to provide high overall production efficiency. It is obvious that a change in the component flow structure also governs changes in the structure of production processes.

Irregularities in the development of various branches of the theory of automated equipment complex design, as applied to areas involving small-scale series production and to the lower levels of the production structure, of course also affect the development of an optimized flexible production system design theory. More attention needs to be directed along these lines. The sum of knowledge will become a theory only upon the formation of a pattern whose order reflects the systemic properties of the object being investigated.

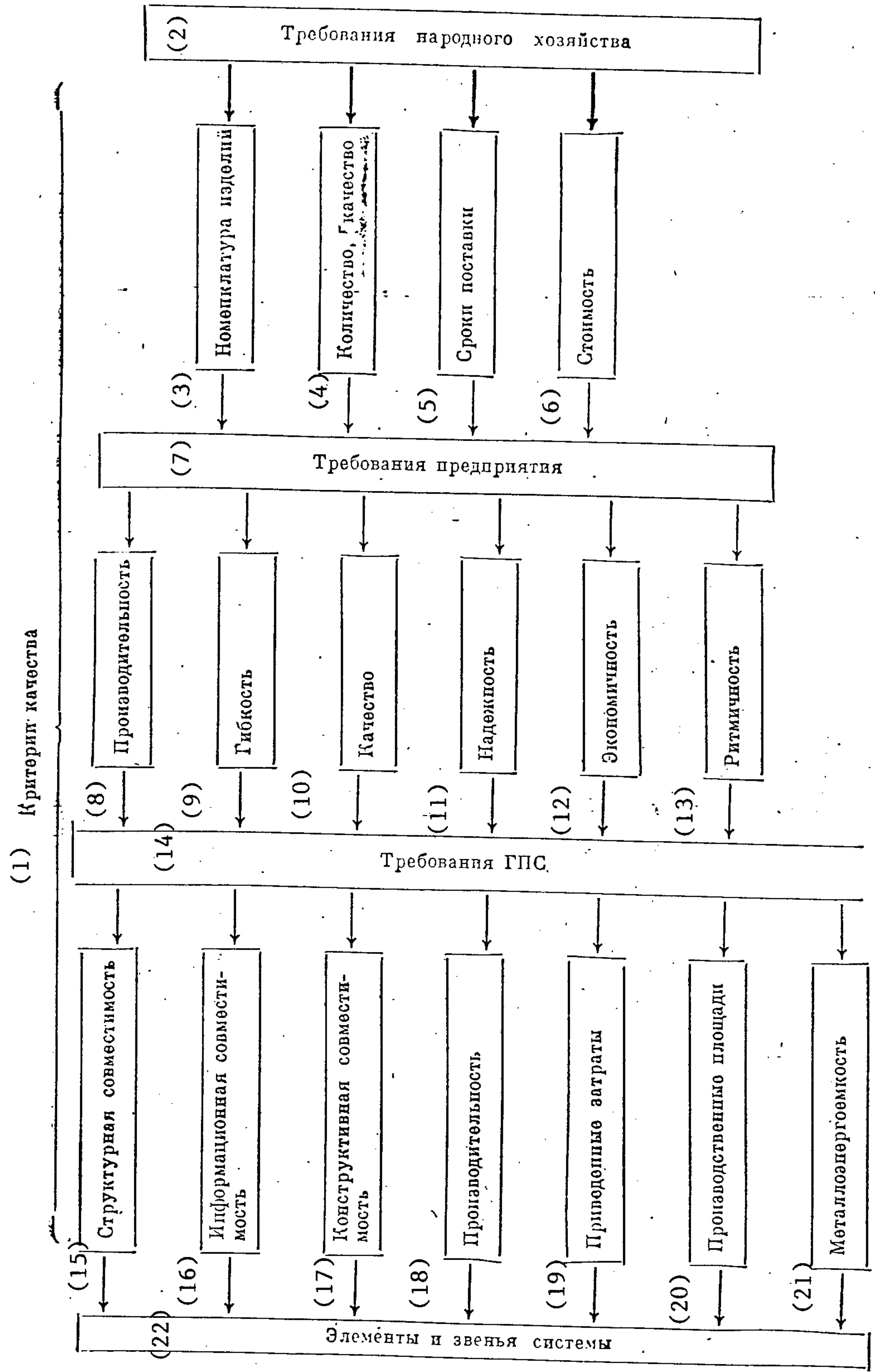

Figure 1. Basic indicators (quality criteria) considered in the development of a flexible production system. [Key appears on following page]

[Key for Figure 1]

1. Quality criteria
2. Demands of national economy
3. Product line
4. Quantity and quality
5. Delivery time
6. Cost
7. Factory demands
8. Productivity
9. Flexibility
10. Quality
11. Reliability
12. Economy
13. Regularity
14. Demands of the flexible production system
15. Structural compatibility
16. Informational compatibility
17. Design compatibility
18. Productivity
19. Effective costs
20. Production space
21. Metal/energy consumption
22. System elements and units

The most promising direction in the development of methods for implementing optimized technical solutions must apparently be found in the rational use of series and mass production automation principles. Additionally, the optimum flexible production system design method must assure the efficiency of these systems for both the producer and the user. This can only be achieved through the use of a modular design principle incorporating standardized components and units to allow the creation of a broad spectrum of different types of flexible production systems. It is obvious that, during the phase in which design methods are developed, a limited number of the most promising flexible production system plans suitable for mass distribution must be formulated.1

The end result of this research must be the creation of an automated design system which uses certain initial data as the basis for analyzing typical flexible production system plans, selecting the most efficient structural and compositional solutions, determining the number of workstations and the type and form of transport networks, working out loading device demands, etc. These systems must be converted to solve one problem or another (flexible production system structure synthesis and analysis, optimized control methods, etc.) on a real-time basis depending on the structure of the initial data entered into these systems. All this not only facilitates the work of those designing specific flexible production systems, it also allows them to use the experience of specialists more qualified in structural synthesis, in the form of application program packages. Further, it assures the selection of an optimum design solution from among an enormous collection of possible variations. This approach eliminates the need for seeking individual means of resolving design tasks under conditions of mass introduction into industry of these types of systems.

This allows even a problem as important as the formulation of technical demands on typical flexible production systems and their components for subsequent development of standardized system elements for various manufacturing purposes to be solved with maximum efficiency. Here the primary goal is the development of technical tasking for flexible production system elements (machine tools, modules, transport and storage systems, industrial robots, devices for control at different levels, monitoring and diagnostic units, etc.), in order to assure that these fulfill system-wide requirements

to the greatest degree possible. This means that each unit must have qualities defined not only by the content of the unit itself, but also by the overall result of the operation of other units. The solution of this problem must result in the formation of a set of criteria for evaluating all flexible production system elements.

Thus, the process of designing individual machines and devices in a flexible production system can only take place after completion of all the steps outlined above, in other words one must skip from the initial design phases characteristic of the traditional approach to the final stage of that approach (Figure 2).

Prerequisites for Successful Completion of a Flexible Automation Program

A successful resolution of the task of introducing flexible automation systems on a mass basis in this country's machine tool building factories is primarily based on plan economics, allowing the targeted implementation of large-scale projects for the national economy, and on a high level of development in this country's scientific and technical potential.

The domestic machine tool building industry is engaged in series production of modern multipurpose machine tools, industrial robots, flexible manufacturing modules with storage units, transport/warehousing facilities and other auxiliary equipment needed in the development of various types of flexible production systems.[2] Great successes have been achieved in the area of mass introduction of stable, high-quality tools and ajustable equipment.[3] The quality, reliability and speed of microprocessor-based numerical control devices and programmable controllers have been increased remarkably in the last decade. The problems of automating diagnostic and monitoring functions have been solved to a great extent.

There is a considerable reserve of scientific knowledge which permits a solution to the problem of complex automation as a whole. Here we must first point out the serious research in the areas of grouped processing and technological classification of components, adaptive methods for dimensional retooling of equipment and optimized design of production process structures.[4]

There is also a certain reserve in the quantitative evaluation of system structural flexibility, allowing the assurance of an efficient flexibility/productivity ratio during the design stage.[5] A number of typical flexible production system structural plans have been developed, as has a package of application programs for evaluating their characteristics. The conditions for providing efficient flexible production system interaction with non-automated production have been identified. Automated design systems have been created for system machine and structure applications, and methods have been developed for the automated design of optimum process structures in the mechanical processing of components within the scope of flexible production systems using grouped technology and standardized production processes.[6]

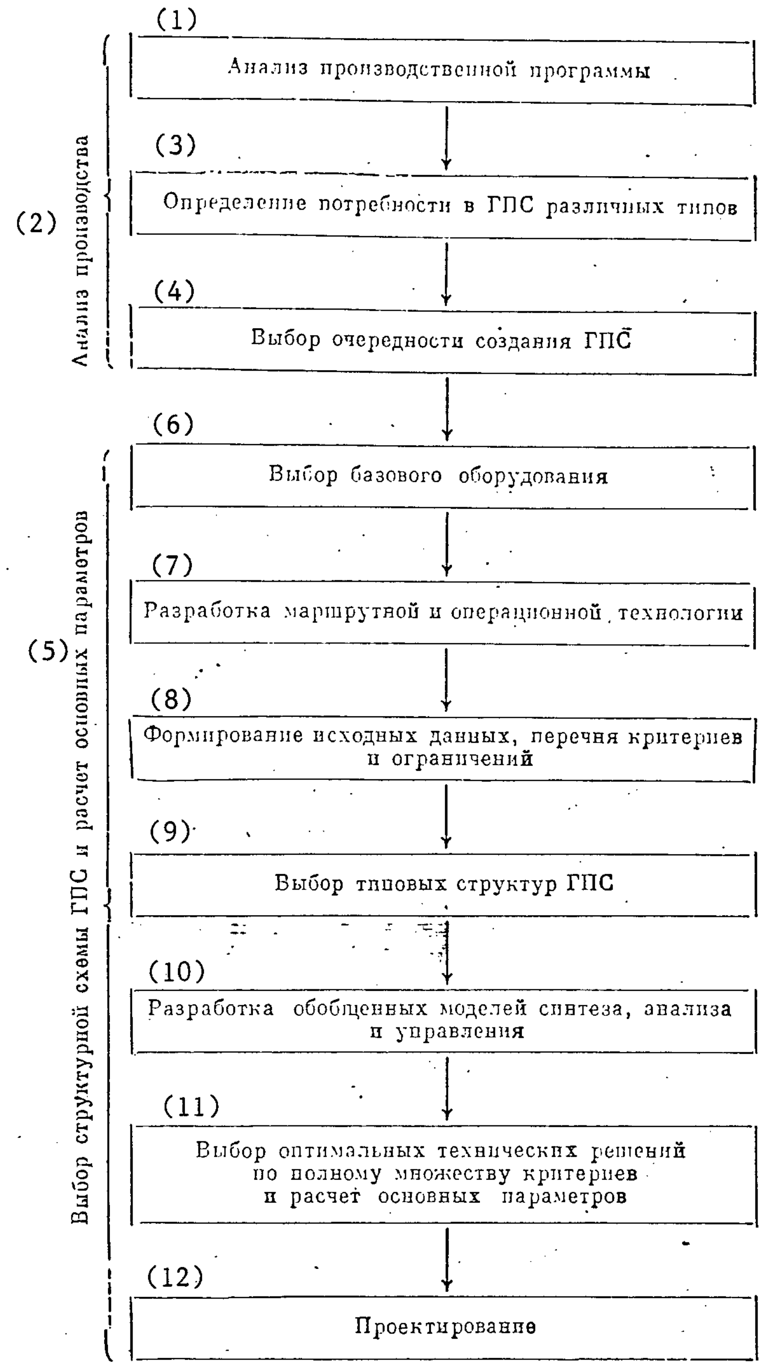

Figure 2. Fundamental stages of pre-design work in the creation of flexible production systems. [Key appears on following page.]

[Key for Figure 2]

1. Analysis of the production program
2. Production analysis
3. Determination of the need for various types of flexible production systems
4. Selection of the flexible production system creation sequence
5. Selection of structural plan and calculation of initial parameters
6. Selection of basic equipment
7. Development of path and operational technology
8. Formulation of initial data, listing of criteria and limits
9. Selection of typical flexible production system structure
10. Development of general models for synthesis, analysis and control
11. Selection of optimum technical solutions according to the complete set of criteria and calculation of initial parameters.
12. Design

The results listed above form an important scientific base for the development of efficient flexible production systems. In this country today, research on automatic dimensional retooling is already being used as the basis for the creation of flexible manufacturing modules which provide programmed automatic readjustment of machine tools upon changes in the components being processed, as well as automatic dimensional calibration and even compensation for cutting tool wear.

Dimensional readjustment programming required the incorporation in the low level control system (numerical control devices and programmable controllers) of a number of additional functions, such as tool identification and measurement and automatic correction of the cutting edge prior to beginning operations as well as during the cutting process in order to provide the given degree of accuracy. In this case work with a previously debugged program and stable manufacturing system characteristics allowed the implementation of flexible production systems in which it is possible to form any path sequence (including piecework production) for parts passing through the machine.

Solution of this task creates prerequisites for the development of flexible automated manufacturing consisting of several flexible production systems (including those for various manufacturing conversions), within which the processing of component combinations can be organized for assembling various types of products. Thus, flow-type production would be organized with a regular output of products on a small scale, eliminating the need for forming component stockpiles prior to assembly. This will allow a marked increase in the production of finished goods at existing factories, the creation of conditions for regular affiliate deliveries, and a notable increase in the mobility and efficiency of the industry as a whole.

However, we must recognize that research on the problem of optimum flexible production system design is not yet well reflected in domestic scientific/technical literature, even though for the creation of flexible systems a solution to this problem is no less important than the formation of

a technical base. In this connection, wider publication of the more interesting results, including the following basic aspects of this problem, seems suitable:

Design; including questions of automated design of basic production (products).

Technology; involving the development of new, progressive processes and their application in the design of high-performance equipment to carry out primary and auxiliary operations without direct human participation.

Organization and control; automated resolution of production planning, organization and control tasks, development of modern systems for controlling and monitoring basic and auxiliary processes, machine operation diagnostics, etc.

Technical and economic aspects; optimization of basic indicators and development of methods for evaluating the efficiency of technical solutions adopted in flexible production systems.

Activating the publication of scientific research results in these areas will not only permit the avoidance of errors in solving particular problems in the synthesis of rational flexible production system structures, it will to a certain extent help in the definition of suitable paths for the development of domestic flexible production systems.

The use of flexible production systems is a major pathway of technical progress in a key branch of industry--machine tool building--and, without a doubt, it will play a prominent role in developing the nation's economy in the coming decades. At the same time, less than optimal scientific, technical and organizational decisions in the design, introduction and operation of flexible production systems could, as indicated above, become major losses. To assure the successful resolution of the most important theoretical and applied problems in this field, it appears necessary to form combined 'ad hoc' teams of scientists and specialists from the Academy of Sciences USSR, the Ministry of the Machine Tool and Tool Building Industry, the USSR Ministry of Higher and Secondary Specialized Education and a number of other sector organizations. This type of work has justified itself repeatedly in the solution of the greatest problems facing the national economy.

FOOTNOTES

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

PROGRESS IN STANDARDIZATION OF FLEXIBLE PRODUCTION NOTED

Moscow STANDARTY I KACHESTVO in Russian No 4, Apr 85 pp 8-9

[Article: "A Gosstandart Scientific-Technical Council Resolution: the Basic Principles of the Standardization and Unification of Automated Complexes and Flexible Automated Production"]

[Text] The scientific-technical council notes that, in carrying out the resolutions of the 26th CPSU Congress and subsequent plenums for accelerating scientific and technical progress and increasing the intensification and efficiency of collective production based on the achievements of science and technology, operations are being carried out in the country in the areas of technical retooling of machine manufacturing enterprises, complex mechanization and automation of production and the creation of flexible automated production systems (GPS's).

In a number of branches of industry, such as Minstankoprom, Minaviaprom, Minelectronprom and others, they have been setting up automated production for various purposes since 1975. At the present time more than 60 automated industries are in operation in the USSR, and their number will grow with every year.

In the three years of the current five-year plan alone, three times as many automated manipulators were manufactured in the national economy as we had available in 1980. In that same period, the production of microprocessors grew five-fold and that of microcomputers more than two-fold. In this way a base is being established for the set-up and widespread institution of flexible production systems.

The projected GPS's stipulate a rational determination of the character of production organization, including specialization of sectors, establishment of unified transport-materials traffic, automated transport-warehouse systems, complex utilization of high-productivity equipment with ChPU [numerical programmed control], robot-technical complexes and automated metering systems controlled by computer.

Problems that require solutions are those of the compatibility of all these elements in the system, of building them into technological and production complexes, of the building-block approach of various types of GPS from unified elements and of the implementation of flexible links among elements.

As is shown by the experience of countries that are technological leaders, the efficient development and implementation of GPS's is impossible without large-scale operations in standardization and unification.

Therefore, alongside the technical base for GPS's, a normative base for setting the systems up is being developed in our country. Programs for complex standardization of industrial robots and equipment with ChPU and programs for operations in the standardization of SAPR [expansion unknown], ASU [automated control systems], YeSTPP [unified system for the technological preparation of production] and a number of others have been prepared and realized in recent years. However, the work being conducted and the programs being developed still do not resolve all the methodological and organizational principles of setting up GPS's.

Attaching great importance to standardization projects, the USSR Council of Ministers, in the resolution "Accelerating operations for the automation of the machine manufacturing industry on the basis of advanced technological processes and flexible readjustable complexes", commissioned Gosstandart and Minstankoprom to provide the 1984-1985 development of normative-technical documentation of the unification and standardization of GPS's. This same resolution entrusted the development of a program of GPS standardization operations for the 12th Five-Year Plan to Gosstandart and Minstankoprom.

In fulfilling this commission, a plan has now been developed for a GPS standardization program for the 12th Five-Year Plan that originates in international experience and utilizes the achievements of the leading branches of domestic industry. The program stipulates the development of a unified normative-systematic base that provides a high technological level, block-module GPS construction and specialization of the manufacture and circulation of highly reliable GPS elements.

The basic trends in the standardization of flexible automated systems, which have been put into the program and were developed by a workers' group at VNIINMASh [All-Union Research Institute for Machine Manufacturing], were discussed and received approval at the first all-union conference "Problems and trends in GAP [flexible automated production] standardization", which took place in Moscow in October 1983.

With a view to coordinating work on state and branch standardization and unification of GPS's, a subcommittee was formed for problems of standardization and unification in the area of establishing flexible production modules, lines, sectors and industrial robots, as well as component parts for them. For the broad discussion of the scientific bases of GPS standardization in the Gosstandart scientific-technical council, an "Industry Automation" section has been set up, into which went the leading scientists and specialists on GPS problems--representatives of branches of industry, secondary education and academic institutions.

Having heard and discussed a paper on the basic principles of standardization and unification of automated complexes and flexible automated production as well as the structure of the GPS standardization program for the 12th Five-Year Plan, the scientific-technical council of Gosstandart resolves:

To approve basic trends in standardization and the structure of the flexible production system standardization program for the 12th Five-Year Plan that was

worked out by VNIINMASh jointly with a workers' group made up of representatives of branches of industry. The systems provide a complex solution to problems of the technological, program, organizational, informational and metrological unity of GPS elements, of compatibility and building in GPS's of various levels, of modular construction and building-block design of GPS's from unified elements and provide standardization of the principles of establishing GPS's and their programmed supply, the establishment of standard GPS components for various types of processing, the establishment of requirements for the control system and a sequence for the functioning and servicing of the GPS.

In accordance with the tasks of the program design, it is considered expedient to define the following ministries and authorities as responsible for the development of the corresponding sections:

Minstankoprom--for the normative documentation that establishes the basic principles of set-up and the technological bases and standard lay-outs of GPS's for various types of processing, as well as the documentation of methods for securing reliability;

Minpribor--for the normative documentation that establishes organizational bases and bases of GPS control and requirements for programmed supply;

Mintyazhmash--for the normative documentation on transportation and warehouse systems in the GPS;

Minelektrotekhprom--for the normative documentation on electric drives for GPS's and electric robot carts;

Gosstandart--for the normative documentation on the technological preparation for GPS's and documentation that operates in GPS conditions.

The ministries of machine manufacturing and instrument engineering are requested during the course of 1985 to define more precisely the state standards for equipment, industrial robots, machining attachments, transport-warehouse systems and control systems in accordance with the fixed nomenclature.

The scientific-technical council recommends that Minstankoprom, Minpribor and Minaviaprom develop temporary technical conditions (VTU) or temporary systematic instructions (VMU).

The institutes of the committee are commissioned to conduct in 1985 an analysis of the general technical systems of standards for YeSTPP, YeSKD [unified system of design documentation], YeSTD [unified system of technological documentation], SAPR, ASU, ASU TP [ASU by manufacturing method], SRPP [expansion unknown] and SSBT [expansion unknown], of standards for computer technology resources (according to the fixed themes) with a view to coordinating their demands with the demands on the GPS, and to give their suggestions for the development and improvement of the above systems of standards.

The Metrology Directorate and the scientific production association of VNIIM [All-Union Research Institute of Metrology] imeni D.I. Mendeleyev are to present to the Directorate of Machine-Tool Industry and to inter-branch industries their

suggestions on the composition of NTD [normative technological documentation] in terms of problems of metrological supply for GPS's for inclusion in the GPS standardization program for the 12th Five-Year Plan.

The Directorate of Machine-Tool Industry and inter-branch industries as well as VNIINMASh, with the participation of Minstankoprom organizations, are to send the SEV [Council on Economic Mutual Aid] institute on standardization, at the specified time, suggestions on the organization of operations on the problem of GPS standardization for the 12th Five-Year Plan in the framework of the SEV.

The Gosstandart scientific-technical council adopted a resolution to conduct the second all-union conference in 1986--"Problems and trends in the standardization of flexible automated production systems".

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TECHNOLOGY PLANNING AND MANAGEMENT AUTOMATION

PROGRESS IN FMS TECHNOLOGY HAMPERED BY ORGANIZATIONAL PROBLEMS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Nov 84 p 2

[Article by Professor Y. Zavyalov, doctor of physical and mathematical sciences, under the rubric "Specialist Opinion": "FMS: Startup Problems")

[Text] Labor productivity in the machine industry over the last 50 years has increased 10 times in basic operations. However, one sees a completely different image in preparatory operations. Regardless of the fact that large design bureaus and plants are equipped with computer technology, engineering productivity has only gone up 33 percent over the same 50-year period. And this "fork" will certainly have a great detrimental influence on the accomplishments in basic production as well as the final outcome of these efforts.

The basic causes of this problem lie in the fact that the possibilities of preparatory production by specialized computers are used only partially since computer centers in design bureaus and plants are equipped with general-purpose equipment. At the same time, for engineer-computer dialogue and to be able to introduce automation elements to design and technological activities, it will be necessary to make substantial additions to existing computers. These changes would take the form of work places. At the present time, there are few of these and the quality (and especially reliability) of those that exist leaves much to be desired.

A second group of causes is the result of a lack of organizations specially involved in software design and mathematical modelling of engineering work. Every design bureau and plant solves this complex problem in its own way. A great shortage of qualified specialists means that existing software packages and programming systems are not always of the best quality because they concern narrow specialized problems. As a rule, they are good only for the internal needs of a given plant, design bureau or at best, a branch of industry.

Such an institutional approach practically excludes any cooperation, duplicates work and wastes efforts and materials. This has been especially obvious in the case of automated programming systems for NC machines that are capable of increasing labor productivity in programming by 10 times. Regardless of the

fact that different organizations have already created many such systems, the problem has still not been solved in its entirety. The purchase in recent years of some foreign software for NC machines has not brought us much closer to solving this problem.

Entering a new stage of automation that uses flexible production, we cannot repeat our old mistakes. If FMS is to immediately show the high level of productivity that we expect, we must work more quickly to create systems for computer-aided design and technological preparation of production. If the creation of these systems does not precede the introduction of FMS, then it must at least be done according to a single schedule.

The software for all of these systems should come together in a set. Therefore the odd programs that are to some extent available today may not form the basis for creating larger sets of programs for the design and technological preparation of production. Furthermore, we must develop software for automated control systems in shops an more. Whenever one speaks today of FMS software, it is often in reference only to direct control of a technological complex. However, this does not take much programming and most of all, it can be carried out in just one step at the same time as the complex itself is created. In distinction to this, machines and robots used in all types of production should have their own particular programs and specialists have therefore calculated that the cost of all of the software eventually needed by a given FMS may exceed by almost 10 times the cost of all of the complex's equipment.

We can with some confidence say that there is no one branch of industry that it is a position to be able to development the necessary software, the volume of which is 10 times greater than that of existing software. In our opinion, the problem can therefore be solved through the creation of a programming industry. The basis for this industry can already be found in subdivisions of the leading academic and branch science research institutes with 10-20 years of experience in the systems programming of production tasks. There are such collectives in Moscow, Leningrad, Novosibirsk, the Ukraine and Belorussia.

For a start, we could bring together the experience of these collectives under a single state program. Of course, the Siberian division of the USSR Academy of Sciences with its large scientific division on automated production problems and its experience in cooperation with individual plants and entire branches of industry could form the head organization coordinating the activity of all other such groups.

In the first stage, it would be possible to work out a common methodology for generating software and to create the basic means. Later, these could be used to properly construct problem-oriented systems for specific types of articles. In this case, one and the same basic means can be used in very remote areas. For example, the means of processing geometric data can be equally well adapted for aviation manufacturing and the modelling of clothes and shoes, the design and manufacture of hydraulic turbines and the plotting of geological maps.

Work on a coordinated plan would be undertaken in the second stage, the creation within the next 5 years of large-scale specialized organizations. These organizations would be able to fully meet the needs of industry and the production of software.

It is no less important at this time to better train specialists on system programming. Along with their knowledge of general problems, these specialists would also be familiar in some detail with computer-aided design and FMS. For this purpose, a series of schools and in particular the Novosibirsk University and Electrotechnical Institute can provide experienced specialists for training.

Unless this complicated series of problems is solved, it will be hard to successfully introduce and efficiently use FMS.

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END